Exploring the Genetic, Neurobiological, and Psychological Mechanisms Involved in the Connection Between Anxious Attachment and Problematic Internet Use

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Abstract— **Internet addiction, a behavioral disorder characterized by excessive and pathological internet use, is a growing concern with profound implications for mental health in today's digital age. Anxious-ambivalent attachment, a subtype of insecure attachment rooted in adverse early life experiences, influences regulation of emotions and interpersonal relationships. Several studies have established a significant correlation between attachment anxiety and problematic internet use (PIU), as individuals exhibiting this attachment style are more prone to internet addiction tendencies. The potential mechanisms underlying the association between internet addiction and anxious-attachment style hold significant importance in the fields of psychology and addiction research. While the specific biological origins of this phenomenon are currently unknown, this review explores the intricate relationships between attachment styles, genetic factors such as monoamine neurotransmitters (dopamine and serotonin), the personality trait of neuroticism, and cortisol stress responses in the context of internet addiction. By establishing these connections, we will be able to better understand the factors contributing to PIU and develop targeted interventions and preventive strategies to combat this increasingly critical public health concern. In this review, we will address the gap in knowledge regarding possible mechanisms driving the association between internet addiction and anxious-ambivalent attachment style.**

I. Introduction

Internet addiction, also commonly referred to as problematic internet use (PIU), is the uncontrollable urge to access the internet. While not officially recognized as a mental disorder, PIU can lead to a decrease in appreciation for non-internet-based activities, jittery or hostile behavior when offline, and a disturbance in socialization [38]. Attachment theory is the effect of early life experiences on children's expectations of the responsiveness and trustworthiness of significant individuals [1]. These expectations play a crucial role in how people behave in relationships as well as their social and emotional development. The anxious-ambivalent attachment style is characterized by a heightened fear of rejection or abandonment [18].

Insecure attachment styles (such as avoidant or anxious-ambivalent) have a direct relationship with internet addiction disorder, problematic smartphone use, and a risk to develop gaming disorder [12, 13, 16]. Research has shown that a majority of individuals who exhibit trends of internet addiction have ambivalent attachments [12]. In one study, despite only a small percentage of subjects having anxious-ambivalent attachment, around 70% of the participants demonstrating internet addiction tendencies had attachment ambivalence [12]. Similarly, individuals with higher attachment anxiety and lower avoidant attachment are more likely to display depressive symptomatology caused by problematic use of social networking services [39]. In addition, these results seem to be consistent between both adolescents and adults, as avoidance towards the mother and anxiety towards the father have been directly linked to PIU, while other variations of insecure childhood attachments are also indirectly correlated with internet addiction [28]. However, while a significant correlation is present, it is still unknown how attachment styles physiologically contribute to the possible development of internet addiction. Therefore, in this review we will explore the potential biological mechanisms that drive the association between the anxious-ambivalent attachment style and problematic internet use.

II. Neurotransmitters And Hormones As Potential Mechanisms

Many studies have demonstrated a relationship between insecure attachment styles and various addictive disorders. In particular, anxious-ambivalent attachment has been associated with internet addiction. A recent study showed that while only 30% of all participants had attachment anxiety, 70% of subjects with PIU tendencies had an ambivalent attachment style [12]. The researchers found that people with an anxious-ambivalent attachment style were primarily motivated by anonymity and social support to access the internet, subsequently developing pathological use. These results suggest that these individuals' social compensation and escapism may serve as moderators for the association between problematic internet use and anxious-ambivalent attachment style [12].

Likewise, another study provided supportive evidence for a correlation between internet addiction and the anxious-ambivalent attachment style [32]. The research demonstrated that the 30 patients clinically diagnosed with internet addiction scored higher on attachment anxiety compared to the healthy controls. While taking into account influences from social or environmental factors, the association between anxious-ambivalent attachment style and internet addiction highlights the potential value of attachment anxiety in predicting the risk of developing internet addiction. These findings suggest that although anonymity and social support play a pivotal role in internet addiction tendencies for those with an anxious-ambivalent attachment style, external factors cannot solely account for such an elaborate phenomenon.

A. Dopamine and genetic correlations between attachment styles and internet addiction

Although anxious-ambivalent attachment style and internet addiction have not yet been physiologically linked,

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several studies suggest that monoamine transmitters such as dopamine may play a role [6, 10]. Dopamine pathways to certain parts of the brain, such as the striatum, influence numerous psychological and physiological functions, including motivational and reward-related behaviors [3]. Furthermore, dopamine is crucial in reward prediction error, or the distinction between anticipated rewards and actual ones [25].

The brain's reward pathways have been extensively correlated with the dopaminergic system, particularly the dopamine D2 receptor (D2R) [5]. Abnormal functioning of D2R can result in various addictive behaviors, including substance abuse and compulsive gambling [5]. The gene that codes for the dopamine D2 receptor (*DRD2*), specifically with the *TaqI A1* allele, has potential involvement in both attachment styles and internet addiction tendencies [14, 17]. For example, ambivalent attachment has been linked with the *DRD2*A1 TaqI* polymorphism, which is associated with a reduced density of dopamine D2 receptors [14]. Similarly, there is a correlation between reduced striatal levels of D2R and problematic internet use [22]. One study hypothesized that specific polymorphisms such as *DRD2*A1 TaqI* in the dopaminergic system may be associated with adult attachment insecurities [14]. These findings indicate that anxious-ambivalent attachment style is linked to multiple *A1 DRD2* alleles, where participants with two alleles scored higher on attachment anxiety than those with fewer [14].

These results suggest that, alongside social experiences, certain genetic polymorphisms in the neurotransmitter dopamine are plausible predictors for insecure attachment. In addition, as multiple studies have concluded that the *A1* allele of *DRD2* is correlated with reduced binding and lower levels of striatal dopamine D2 receptors, anxious-ambivalent attachment style is likely to also be linked with these effects [19, 30]. Moreover, decreased levels of D2R correspond with reduced maternal responsiveness, and inconsistent responses from maternal figures are also associated with insecure attachment styles [2, 8]. Collectively, these findings suggest that anxious attachment may be correlated with a reduction in striatal dopamine D2 receptors through the TaqI A1 polymorphism as well as having a mutual association with poor responsiveness from maternal sources.

Similarly, the *DRD2*A1 TaqI* allele has been implicated in excessive internet video game play, a subtype of internet addiction [17]. The study found that the participants with internet addiction had a higher occurrence of the *DRD2*A1* allele compared to controls. This suggests that genetic polymorphisms in dopamine, particularly the *DRD2*A1 TaqI* allele, are associated with reward dependence and contribute to internet addiction [17]. Likewise, another study investigating possible neurobiological mechanisms underlying internet addiction demonstrated that individuals with PIU exhibited reduced levels of D2R in the striatum, particularly the bilateral dorsal caudate and right putamen [22]. These findings demonstrated that internet addiction may have physiological similarities to other addictive disorders involving substance abuse [22]. Consequently, these studies hint at possible workings of the association between anxious-ambivalent attachment style and problematic internet use by highlighting the significance of the dopamine D2 receptor gene in provoking addictive behaviors. Taken together, the association between two *A1* alleles of *DRD2*, reduced availability of striatal dopamine D2 receptors, and anxious-ambivalent attachment style may serve as a predictor for the development of internet addiction disorder. Therefore, further research is needed to investigate the potential overlap between anxious attachment, reduced striatal dopamine D2 receptors due to the *DRD2*A1 TaqI* polymorphism, and internet addiction.

B. The serotonin 5-HTTLPR polymorphism and implications with neuroticism, attachment anxiety, and problematic internet use

The monoamine transmitter serotonin, particularly its transporter (5-HT), may be associated with the correlation between anxious-ambivalent attachment style and internet addiction. Serotonin modulates various behavioral and neurological processes including mood, perception, reward, aggression, memory, and attention [4]. Beyond its extensive involvement in neurobiology, 5-HT is also involved in numerous disorders in the central nervous system such as depression, anxiety, schizophrenia, obsessive-compulsive disorder, addiction, and Parkinson's disease [9]. A specific polymorphism in the promoter region of the serotonin transporter gene (*5-HTTLPR*) has potential implications for attachment anxiety [35]. For example, attachment insecurities have been significantly associated with the short allele variant of *5-HTTLPR*, which is likely due to its genotype influencing components that trigger attachment behaviors, such as emotional responsiveness or reactivity to threatening stimuli [35].

Consequently, the researchers in one study hypothesized that polymorphisms in the serotonin transporter impact sensitivity to parental behaviors or cause biases when taking in information, leading to negative interpretations of childhood experiences [35]. These conclusions suggest that the short allele of the *5-HTTLPR* polymorphism may be implicated in brain development and the effect of adverse childhood experiences on attachment style, which could potentially explain why individuals with anxious-ambivalent attachment style seem to be susceptible to internet addiction [32]. Moreover, *5-HTTLPR* is also correlated with problematic internet use, particularly the variant with homozygous short alleles [24, 34]. One study showed that the participants with homozygous short alleles in *5-HTTLPR* demonstrated significantly higher scores of internet addiction compared to those with long alleles [34]. The researchers suggested that the association between *5-HTTLPR* short alleles and a decreased risk of inattentiveness contributes to Internet overuse, the collective phenomenon of internet addiction [34].

Likewise, another study substantiated these results by demonstrating that individuals with PIU exhibited a higher frequency of the *5-HTTLPR* homozygous short allelic variant compared to healthy controls [24]. Collectively, this evidence suggests that anxious-ambivalent attachment style

and PIU may be linked by changes in *5-HTTLPR*. Consequently, these studies provide a plausible mechanism for the correlation between anxious-ambivalent attachment style and problematic internet use, emphasizing the role of the short allele of the *5-HTTLPR* in provoking risk for internet addiction. The convergence of these results reveals a potentially compelling channel for linking anxious-ambivalent attachment style to the development of problematic internet use. Further research is needed to investigate the physiological overlap between anxious-ambivalent attachment, *5-HTTLPR* influencing brain development, and its association with high attentiveness playing a role in developing internet addiction.

In addition, the *5-HTTLPR* polymorphism and attachment anxiety have both been linked to issues with coping, a heightened sensitivity to criticism, and neuroticism, the tendency to experience negative emotions [27]. Compared to individuals with other allelic variants, subjects with homozygous short-alleles of *5-HTTLPR* had significantly elevated neuroticism scores [23]. Furthermore, several other studies have supported the correlation of *5-HTTLPR*, specifically with the short allele, to the presence of neurotic symptoms [15, 33]. Comparably, anxious-ambivalent attachment style has a significant and well-documented relationship with neuroticism [14, 29].

Both attachment anxiety and neurotic personality are conceptually similar and are characterized by facets of insecurity, depression, vulnerability, and anxiety [29]. Similarly, one study found a correlation between neuroticism and the likeliness of developing internet addiction, which was mediated by anxious feelings toward online interactions [7]. According to the researchers, people with neuroticism used the internet to develop a sense of social belonging in order to increase self-esteem [7]. Correspondingly, heightened fear of rejection or abandonment is a characteristic of attachment anxiety [18]. Therefore, as the association between internet addiction and neurotic personality is mediated by anxious feelings, it could be possible that the heightened fear of abandonment from attachment anxiety could drive individuals to become more dependent on the internet, causing pathological internet use.

These studies all suggest a correlation between attachment anxiety, the short allele of *5-HTTLPR*, and problematic internet use in regard to a correlative association with neuroticism. In addition, the influence of serotonin on cognitive and emotional processes and its possible involvement in psychiatric disorders highlights the complex interactions of *5-HTTLPR*, anxious-ambivalent attachment style, and internet addiction, thus underlining the need for a deeper understanding of the factors contributing to problematic internet use. Further research is needed to pinpoint how *5-HTTLPR* can impact brain development and how neuroticism may provide an explanation for the relationship between anxious-ambivalent attachment style and problematic internet use.

C. Blunted cortisol responses to stress as a neurobiological correlation between anxious attachment and internet addiction

Similarly to serotonin and dopamine, the steroid hormone cortisol, particularly its involvement in stress response, has a demonstrated involvement in the correlation between anxious-ambivalent attachment and internet addiction. When stress is experienced, cortisol is released from the adrenal glands to regulate the magnitude and duration of inflammatory responses [31]. The hypothalamus controls the secretion of cortisol, which is acutely sensitive during times of stress [31]. Several types of addiction, such as substance and alcohol abuse, have been linked with dysregulated cortisol stress responses [26]. In fact, one study demonstrated that, compared to healthy controls, subjects with internet addiction had blunted cortisol responses to psychosocial stressors [36]. Another study had similar results, where patients with internet addiction exhibited attenuated cortisol response to acute stress (as opposed to the healthy participants) [21]. When integrated, these studies indicate a strong correlation between internet addiction and dysregulated cortisol levels in response to stress. The association between dysregulated cortisol responses and addiction processes is significant in understanding how the risk for internet addiction may develop.

In addition, the interactions between anxious-ambivalent attachment and adverse childhood experiences have been found to be moderated by blunted cortisol reactivity in response to a stressor [11]. This suggests attachment anxiety may share similar stress responses to those with internet addiction; both anxious attachment and PIU are associated with lower cortisol levels in response to an acute stressor. Additional studies are required to delve deeper into the precise nature of this elaborate relationship and the broader implications it may hold for understanding the ties between internet addiction, anxious-ambivalent attachment, and cortisol.

III. DISCUSSION

The present review explored the potential mechanisms underlying the association between anxious-ambivalent attachment style and problematic internet use, highlighting the various complexities of behavioral addiction. For example, the research indicated that individuals with anxious-ambivalent attachment are more likely to develop internet addiction tendencies, driven motivationally by anonymity and social support [12]. The presence of two *A1* alleles in *DRD2* and the short allele of *5-HTTLPR* were correlated with both attachment anxiety and problematic internet use [24, 34]. Both anxious-ambivalent attachment and internet addiction were also linked to elevated levels of neuroticism, hinting at a shared psychological predisposition [7, 14, 29]. Furthermore, dysregulated cortisol stress responses were implicated in the correlation between anxious-ambivalent attachment and internet addiction due to blunted cortisol reactivity being mutually associated [11, 21, 36]. Collectively, these workings demonstrate the multifaceted interactions between genetic, neurobiological,

and psychological factors in the link between anxious attachment and problematic internet use. Further research is crucial to comprehend the intricate nature of this relationship and its implications for addiction development.

However, there are several limitations to this review. Firstly, the studies cited are predominantly cross-sectional, which allow for correlational but not causal studies. Therefore, longitudinal studies are necessary to establish a definitive and causal relationship between anxious attachment style and internet addiction. In addition, many researchers primarily used methods of self-reporting to determine the attachment styles of subjects, making the findings potentially susceptible to personal bias and desire for social conformity [12, 39]. Therefore, future studies should include standardized and validated behavioral or physiological assessments to more accurately pinpoint other aspects of attachment, as opposed to reports from the participants themselves.

Next, the majority of the studies focused on relatively similar cultural backgrounds as well as specific age groups, where the participants were solely adolescents or young adults. Given that attachment styles and internet use tendencies may vary across a wide range of age and culture, the results may not be consistent when testing broader populations. Samples with more diversity are needed to validate these associations.

Furthermore, the biological mechanisms proposed in the reviewed studies are mainly correlational. While there is evidence linking specific genetic polymorphisms, such as *DRD2 TaqIA* and *5-HTTLPR*, to attachment styles and internet addiction, the precise biological underpinnings have not been fully explored. Future research should focus on identifying specific neurobiological pathways and genetic factors that may interact with insecure attachment to contribute to the risk of developing problematic internet use.

Likewise, although attachment and genetic factors were found to be significant in driving PIU, internet addiction is a complex phenomenon with influences from a variety of individual, social, and environmental factors, which should be considered when analyzing the relationship between internet addiction and anxious attachment style [20]. Therefore, these limitations highlight the need for more accurate methods of determining attachment, diversity in samples, and a consideration of other factors contributing to problematic internet use. Addressing these limitations will ultimately be crucial in strengthening our knowledge of the link between insecure attachment and PIU.

Additionally, as adverse early life experiences shape attachment style , the role of traumatic events during childhood can be another avenue for exploration in order to understand the development of these problematic behaviors [37]. Further research can aim to uncover whether insecure attachment styles serve as risk factors for addictive behaviors as well as the dynamic between attachment and internet addiction through neurotransmitters and stress response, which will help in producing therapeutic interventions. For example, as the association between problematic internet use and insecure attachment becomes clearer, developing therapy for internet addiction such as attachment-specific drug treatments can focus on polymorphisms in monoamine neurotransmitters or stress hormones.

IV. Conclusion

This review sheds light on the association between the anxious-ambivalent attachment style and problematic internet use by proposing several prospective mechanisms that may sustain this connection. The evidence presented in this review suggests that individuals with an anxious-ambivalent attachment style are more prone to problematic internet use tendencies than others, with genetic polymorphisms in dopamine and serotonin, heightened levels of neuroticism, and altered cortisol stress responses as potential contributing factors. While these findings introduce possible moderators for this association, the precise channels linking attachment style to internet addiction are highly intricate and warrant further exploration. Overall, these findings demonstrate the elaborate interactions between genetic and psychophysiological factors, offering valuable insights into the complexities of behavioral disorders and insecure attachment.

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